enerSave
For Municipalities

Energy and Urban Transportation

Energy, Mines and Resources Canada
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9

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Contents

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Energy and Urban Transportation

Introduction

The movement of people and goods in Canadian cities accounts for fully one quarter of Canada's oil consumption. And 70% of this energy is used to fuel the private automobile. Changing patterns of auto use, therefore, can mean big reductions in community energy consumption. When accompanied by measures to improve public transit and traffic flow, disincentives for low occupancy automobile travel can be the underpinning of energy-sensitive municipal transportation policy.

Unlike most energy initiatives examined in this series of booklets, energy-sensitive transportation policies generally produce only indirect savings for the municipal purse. Yet in the long term the associated benefits are significant: more efficient public transit and less congestion in the streets, with lower road maintenance and construction costs. Moreover, it is increasingly apparent that measures which promote energy efficiency within the larger community are an important feature of good municipal government.

For smaller municipalities, many issues discussed in this section will be of theoretical interest only. In the field of urban transportation the size of a community limits both problems and possibilities. Whatever its size, however, every municipality should take a close look at ways of discouraging low-occupancy auto travel. Bikeways and footpaths, for instance, can be introduced in a community of any size. And ride-sharing may in fact offer smaller municipalities an inexpensive alternative to new or expanded transit operations.

The transportation measures discussed are divided into four categories: alternatives to low occupancy auto travel, disincentives for auto travel, improved traffic flow, and road maintenance and construction. The key to energy-efficient transportation planning is recognition that no single measure will reduce energy consumption significantly. Only by introducing a package of complementary measures can municipal planners achieve significant energy savings. And since each community is unique, this package must be based on a thorough review of local circumstances and existing policies.

1- Encouraging the Use of Public Transportation

Persuading people to use public transportation instead of automobiles has proven difficult. In the last few years this issue has been the focus of extensive research. Studies indicate that the following measures are particularly important in encouraging a switch to transit.

Increased transit speeds

Reducing transit travel time is generally the best way of increasing ridership on public transportation. Studies have shown that a reduction of 10% in travel time during peak hours alone will result in a 3% reduction in automobile use. Municipalities can introduce various measures to make transit travel times more competitive with those of private automobiles. At the same time each of these methods improves bus fuel economy, providing direct cost savings in transit operations.

- Express Bus Service - In general transit vehicles travel at a lower average speed than automobiles since they make frequent stops to take on and let off passengers. An express bus service may be possible for long trips, making use of urban expressways. By eliminating intermediate stops, the through portion of the route can be made as fast by bus as by private vehicles. Express bus service is best for municipalities with a fairly large transit ridership and a high demand travel corridor leading to a concentrated downtown area.

- Transit Priority - If priority is given to transit service along heavily travelled roads, travel time will become even less than for private vehicles travelling in adjacent lanes.[5] Priority treatment can take many forms, from the construction of an exclusive right-of-way lane for transit vehicles to allocation of an existing roadway lane exclusively for transit.

- Expressway bus lanes can greatly improve express bus service to outlying areas. These bus lanes should be provided in the normal direction of traffic only where the necessary traffic capacity exists. Generally, conditions will suggest designating bus lanes in lanes normally moving in the opposite direction to peak traffic ("contra-flow"). In most cases traffic in the direction opposite to peak flow is light, and "contra-flow" bus lanes therefore do not reduce the flow of traffic in the peak direction.

  In 1974 the Regional Municipality of Ottawa-Carleton introduced an exclusive bus right-of-way by closing the two off-peak direction lanes on the Ottawa River Parkway to all but bus traffic during peak hours. By 1975 the ridership on this route increased by 46% in the morning peak period and 70% in the evening.[8]

  The most common bus lanes are those that provide priority to buses moving in the same direction as traffic. These special bus lanes are inexpensive to implement and require minimum street routing changes. Motorist cooperation is difficult to enforce, however, and in some cases only marginal improvements are made to bus flow. With contra-flow bus lanes, non-bus traffic has no alternative but to remain in the proper lanes.

- Preferential bus entry to expressways can be provided at ramps by designating one lane of an existing ramp for bus use only, or by converting the ramp to exclusive bus use.

  At urban intersections buses can be exempt from turning restrictions imposed on other types of vehicle traffic. Adjusting traffic signal timing at intersections to facilitate bus flow can substantially reduce bus trip times and improve fuel economy. Bus delays at traffic signals usually account for 10 to 20% of total bus trip times, and almost 50% of all delays.

  Priority can also be given to transit vehicles by exempting them from the restrictions placed on the use of automobiles in downtown areas.

- Simplified Fare Collection - Transit speeds will be increased by eliminating ticket sales by drivers. A fare collection system can be introduced involving ticket sales at commercial outlets dispersed along each route, an exact fare policy for passengers who pay cash, and/or a bus pass system.

Raised numbers in the text refer to sources listed in the bibliography.

Fare pricing policy

Although transit is less expensive than the private automobile as a means of transportation, many travellers believe it to be more costly because they consider only their out-of-pocket costs (e.g. gasoline and parking) and not the full costs of owning and operating an automobile. This misconception can be overcome to some extent if fares are paid by transit passes, valid for an unlimited number of trips during a specified time period (e.g. one month.) With such a system travellers perceive no cost for extra non-commuter transit trips.[3]

Fare reductions have been suggested as another method of making public transportation more attractive to auto users. Results of fare reduction experiments conducted in Europe and the United States, however, have shown that a 10% reduction in fares increased ridership by only 2 to 4%.[6,7] Furthermore, only about 2% of automobile users switched to transit.[6] The consensus is that fare reductions are an ineffective inducement, and since this approach increases the transit deficit it is not recommended.

More convenient and comfortable transit

- Reduce Walking and Waiting Time - Many people prefer travel by private automobile because, unlike most conventional forms of public transportation, it offers door-to-door service. To reduce waiting time, and the time required to walk to and from transit, the area covered by existing routes can be extended and bus frequencies increased. Although effective in high density areas, such improvements to the level of service may increase the fuel consumption ridership ratio in low density areas.

  A more practical method of reducing waiting times without increasing the number of bus miles is a transit control and information system known as Teleride:* to find out when the next bus will arrive, the user simply dials a telephone code identifying the route and stop number. These types of systems vary considerably in sophistication and cost, and the most appropriate for a municipality will depend upon the size and complexity of the existing transit system.

  Essentially there are two types of Teleride systems. The more sophisticated and expensive of the two tells the user exactly when the next bus will arrive at the stop concerned. This system relies on precise, signal-relayed information indicating the location of the next bus at the time the call is made. The second type can be operated for about one tenth the cost of the first. Rather than providing precise information on when the next bus will arrive, this system merely informs the rider of the expected arrival time based on the bus schedule.

  In 1977 Mississauga's 100-bus transit commission embarked on a pilot project using the more sophisticated type of Teleride system. Within two years ridership went up 20-30% on weekdays and 30-60% on Saturdays. Moreover, the overall transit deficit went down by 30%.

- Provide Shelters and Benches - Shelters and benches can effectively reduce the discomfort of long waits and inclement weather.

- Provide Park-and-Ride Facilities - Large metropolitan areas with rapid transit lines, e.g. commuter rail, subway and light rail, can improve access to the system by providing parking facilities at outlying stations. Such facilities are particularly useful in low density areas for which a feeder bus service is not feasible.

- Dial-A-Bus - Dial-a-bus systems, like taxis, offer a high level of personal service by providing doorstep pick up on the basis of a telephone request. Unlike conventional taxis, however, the bus may make detours to pick up or drop off other passengers.

  There are basically three variations of a dial-a-bus service: service from the passengers' doorsteps to a single point, e.g. transit station or shopping centre, to a few locations where transfers to other transit routes are possible, or directly to any destination in the operating area. Several combinations of fixed and totally demand responsive schedules are possible. Dial-a-bus services which are very demand responsive (i.e. door-to-door service at any time) are energy intensive because of low load factors and long distances travelled.[1]

  This type of service was not originally conceived with energy conservation in mind. Careful system design and equipment selection, however, may improve the efficiency of dial-a-bus and make it an energy-saving alternative over low occupancy buses and automobiles.

Rescheduled work hours

Rescheduling work hours in the community can also improve transit service and make it a more attractive option to commuters. Either of the following methods can be used:

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* Teleride, 156 Front Street West, Toronto, Ontario M5J 1G5. Telephone (416) 596-1940.

- staggered hours, where the employer establishes different working hours for different groups;
- flex-time, where the employee picks his own working hours around a core period.

Both staggered hours and flex-time work schedules produce an important decrease in traffic congestion by spreading a one-hour peak demand to three or more hours: hourly traffic volumes drop, decreasing the frequency of stops and increasing average travel speed for buses. Bus trip times are shortened, average occupancies decrease, and better scheduling becomes possible.

Such programs can result in major benefits not only by improving transit operation and increasing ridership, but also by decreasing traffic congestion during peak commuting hours.

A flexible work-hours program in the National Capital Region includes virtually all federal government employees as well as employees of other large institutions. In total, close to 50% of employees in the urban core of Ottawa and Hull are affected. This innovation has resulted in important benefits to the transit system:

- an increase in ridership over the entire peak period
- a decrease in ridership during the peak hour
- significant improvements in transit operating efficiency

A rescheduled work hours program, however, must involve a significant proportion of a community's labour force to be effective. Widespread employer cooperation is therefore essential.

The four-day work week offers another possibility for reducing community energy use. While it is true that a four-day work week will reduce energy used for commuting by 20%, an increase in mini-vacations on the extended weekend may consume more energy than the amount saved.

2- Encouraging Ride Sharing

Commuting to and from work is less energy efficient than any other kind of automobile travel - more than 70% of auto commuters travel alone, and the average occupancy per auto is only 1.2. Thus ride-sharing policies offer significant reductions in automobile fuel consumption.

Long distance commuters make up 25% of all commuters, and yet this group consumes over 50% of the fuel used for commuting. The target market for ride-sharing is therefore the long distance commuter with a travel-to-work distance of ten miles or more. Due to physical and financial constraints, public transit seldom offers the typical long-distance commuter good service, if it offers any service at all. Most of these commuters consider themselves wholly dependent on their automobile.

For municipal governments, ride-sharing programs are particularly attractive because they require relatively little capital investment and involve negligible operating expenditures.

Vanpools

Of all urban transportation alternatives, vanpools can probably make the greatest contribution to energy savings on a per passenger-mile basis.[1] Operating during peak hours only, and with near capacity loads, each passenger van removes several cars from the road, saving as much as 5,000 gallons of gas each year and providing commuter transportation for up to fifteen people.

In a vanpool, each passenger pays a periodic subscription rate to cover one share of the loan or lease payments, fuel, insurance, and maintenance expenses. The driver, also a commuter, is not paid for driving the van. In return for his service, he or she receives free commuter trips plus use of the van weekday evenings and weekends for a nominal mileage charge. In some cases, to encourage drivers to involve as many passengers as possible in the pool, the driver is allowed to keep all or a portion of the fares over and above a predetermined break-even threshold.

Unfortunately, the vanpool concept and the benefits it offers remain relatively unknown in Canada, although there are now more than 12,000 vanpools operating in the United States. In the last few years several

Canadian firms have introduced vanpooling,* many under a Federal/Provincial Vanpool Demonstration Program launched in 1978. Results from the program have been positive, and considerable interest is now developing among both large and small employers across the country.

Vanpools offer significant benefits both for employees and employers. Major advantages to employees include:

- financial savings (anywhere from $5 to $100/month/employee)
- the possible elimination of the need for a second car
- convenient and reliable door-to-door service
- the elimination of parking problems
- a friendly, social club-like atmosphere.

Surveys of existing vanpools have confirmed that dollar savings are the strongest inducement for getting employees interested in vanpooling. The same surveys reveal, however, that experienced vanpoolers rate convenience and personal friendships higher than the cost savings.

For the employer the main benefit may be a reduction in parking lot construction and maintenance. The 3M Company of St. Paul, Minnesota claims it has saved 2.7 million dollars in parking-related expenses as a result of its program, which includes more than 115 vanpools. Other employer benefits include:

- improved corporate image
- improved labour-management relations
- reduced tardiness
- reduced absenteeism.

Carpools

Carpools can also make a significant contribution to energy conservation. Like vanpools they divert commuters from low occupancy autos, and are second only to vanpools in the amount of energy they can save. However, there are major differences between the two.

First, unlike vanpools, carpools need not be limited to long distance commuters, or even to commuters. Secondly, while carpools may not offer as great a financial incentive as vanpools, they do not always require the highly formalized organizing and operating procedures necessitated by vanpool operations.

Recognizing that carpools can be organized independently and on a very informal basis between two or more individuals, Ontario's Ministry of Transportation and Communications set up a number of carpoolers' parking lots on the edges of Toronto in the fall of 1979. Surveys revealed that virtually all the lot users were travelling to work, and approximately 75% of those surveyed used the lots at least five times per week.

Selling Canadians on carpooling is by no means an easy task. Before embarking on any form of area-wide program a number of factors must be considered, with particular attention to the potential carpool market, its characteristics, and the do's and don'ts of carpool marketing:

- To avoid any counterproductive competition between efficient options, carpools should not be promoted in areas that are well served by public transit. Both incentives and disincentives can be introduced to support the program. Municipalities should consider instituting penalties such as higher parking charges and forbidding access to certain lanes or routes. They can also allocate preferential parking spaces to carpools. This approach encourages the solo driver to choose between energy-efficient alternatives without undermining either the transit system or the carpool.

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* Employers involved in the demonstration program are Versatile Manufacturing (Winnipeg), Bell Canada (Toronto), the Government of New Brunswick (Fredericton), the Government of Prince Edward Island (Charlottetown), and ERCO (Long Harbour, Nfld.).

Prior to the demonstration program, Chrysler Canada Ltd. and 3M of Canada Ltd. set up their own respective vanpool programs. Both programs are operating very smoothly and have undergone considerable expansion.

Vanpool information is available by writing to Vanpools, Conservation & Renewable Energy Branch, Energy, Mines and Resources, 580 Booth Street, Ottawa, Ontario, K1A 0E4

- In areas where travel-to-work distances are short, the carpool market is limited. Thus, like vanpools, the target for carpools lies primarily with long-distance commuters, those for whom dollar savings can be significant and for whom public transit service is either poor or not available.

Van and carpool marketing: what municipalities can do

A number of options are open to municipalities.

- As employers, municipalities can help set up a van or carpool program for their own employees where circumstances warrant it. By demonstrating the advantages of ride sharing in this way, local governments can set an important example for other employers in the municipality.

- Municipalities can encourage large employers, particularly those located in non-central locations, to develop vanpool programs. For best results large employers programs should be company-specific with direct management involvement. Typically, this would involve the appointment of a vanpool administrator, marketing the program for employees, purchasing or leasing the vans in the company's name, establishing a payroll deduction plan, and handling general administrative matters. Normally this administrative back-up involves only a fraction of a man-day per month.

- Municipalities can also consider establishing a third party ride-sharing centre to stimulate community-wide interest in ride-sharing, organize vanpools and carpools on a multi-employer basis, and act as a general pool-people matching centre. As company-specific vanpool programs are usually not viable for employers with less than 150 employees, such centres could provide employees working for small firms with the opportunity to join vanpools. United States ride-sharing centres such as Rides for Bay Area Commuters Inc., San Francisco, could be used as models for setting up Canadian centres.

- Supportive measures can be introduced. Preferential parking, particularly in downtown areas where parking supply is limited, is a common incentive for car and vanpools. It is most effective when combined with increased parking charges in publicly owned lots. Specific lanes on expressways and arterials can be designated for the exclusive use of high occupancy vehicles during peak periods, the improvement in travel time often compensating for delays at the beginning of a trip picking up passengers. In addition, areas of the city can be restricted to high occupancy vehicles during peak hours.

3- Discouraging Low Occupancy Travel

If steps to improve the use of public transit are to have an impact, they should be supplemented by measures to discourage use of private vehicles.

In fact, it has been found that strategies which penalize automobile travel achieve almost twice as much energy savings (per additional transit passenger gained) as measures to improve the level of transit service.[11] Only automobile drivers and passengers are affected by automobile disincentives, whereas improvements to transit service also benefit regular transit users. There are several methods that can be used to discourage people from using their automobiles.

Redirected traffic

By forcing automobile users to take "out-of-the-way" routes, travel times for the private automobile are increased. When buses are exempt from these restrictions, auto users may be persuaded to leave their cars to take advantage of the faster travel time available on public transit.

- <u>Traffic Cells or Zones</u> - Traffic can be redirected by dividing an area into traffic cells or zones.[12] Examples of this technique are found in Gothenburg,

Sweden and Bremen, West Germany. Pedestrians and transit vehicles are permitted to cross boundaries between these cells, but private automobile movement from one cell to another is allowed only via arterial roads on the perimeter of the controlled area. Cell boundaries are marked with white lines or small raised barriers, and street signs direct private vehicles to the most efficient perimeter route.

Traffic cells are most appropriate for relatively large cities with old downtown areas and limited opportunities for expanding the capacity of the existing street system without considerable disruption.

- Auto-Free Zones - A second method of redirecting private vehicles is to create auto-free zones in which all use of private automobiles is prohibited. Access to these areas is permitted only to emergency vehicles and to delivery trucks at specific hours of the day.

  Auto-free zones are applicable to downtown areas of both large and small municipalities. There are numerous examples of auto-free zones in Europe and, to a lesser extent, in the United States.[12] Apart from their impact on traffic auto-free zones appear to improve trade within the zone considerably, increasing sales in commercial areas.

  Both traffic cells and auto-free zones will result in fuel consumption savings only if automobile users are persuaded to switch to public transportation. Otherwise, fuel consumption may actually increase because of the longer distances private vehicles must travel to get to their destinations.

  Since automobile users are unlikely to switch unless they see transit as a reasonable alternative, it is essential that projects restricting use of private vehicles in certain areas are accompanied by an attractive transit service.

- Area Licencing Approach - This offers a more flexible method of restricting automobile use than creating auto-free zones. The most celebrated example of this scheme has been set up by the City of Singapore[13] and involves a restricted zone around the central business district. During morning peak hours, private automobiles, including taxis, cannot enter the restricted zone without displaying a supplementary licence which must be purchased monthly. Buses, commercial vehicles and carpools are exempted from the scheme.

  Surveys indicated that there was a substantial increase in the number of carpools (82%), that the morning peak period was spread out, bus travel times were improved (25%) and that ridership increased (15%). Since more than 75% of all commuters travel by bus, a 15% transit increase represents a significant diversion of automobile drivers to transit.

Pricing disincentives

Since fuel economy is low during peak periods of congestion, one method of discouraging low occupancy automobile use is to charge private vehicles for the use of the roadway during these periods. Road user charges can inhibit road use to the point that some drivers will avoid travelling in the peak periods, thus improving traffic circulation and overall fuel efficiency. Peak period charges may also encourage drivers to travel by public transportation or to form car and vanpools, which would be exempt from any charges.

At present, the most feasible pricing disincentives available appear to be tolls collected[12] upon entry to controlled routes, restricted area licences, and parking charges.

- Tolls - The use of tolls is most feasible where access from major residential developments is restricted by geographical barriers (such as bodies of water) to only a few routes.

- Parking Surcharge - The most generally acceptable pricing mechanism for discouraging automobile use, increasing parking charges encourages formation of carpools to share parking costs and makes transit more attractive as a way to avoid costs.

  To discourage commuter parking, yet not adversely affect retail establishments, a system of graduated parking charges

can be instituted: charges are set up so that short-term parking is relatively inexpensive and all-day parking is very expensive.

One problem with parking charges is that the majority of employees benefit from free or subsidized parking at their place of employment and therefore are not affected by this disincentive.

Limits to the supply of parking

In addition to discouraging automobile use through high parking charges, municipalities can limit parking supply in downtown areas. For instance, on-street parking can be prohibited during peak periods and limited at other times to a maximum of two hours. Removal of parking during peak hours will also improve traffic circulation significantly.

Finally, most large municipalities have by-laws requiring that all office towers include parking space equivalent to a specific proportion of the total office space available. These by-laws can be changed to limit the number of parking spaces provided by new development.

4- Improving Traffic Flow

Up to this point we have been looking at ways to encourage higher vehicle occupancies and to reduce vehicle use. In most municipalities, however, a substantial proportion of trips must still be made by automobile, and here too energy savings are possible: traffic engineering techniques can reduce energy consumption significantly by improving traffic flow in and around the municipality. In addition, rescheduling work hours can result in major improvements in traffic congestion levels.

Traffic engineering techniques

- Signals - Slight changes in traffic patterns can result in unnecessary congestion which minor adjustments to the timing of signals will remove, e.g. more left turns because of a new subdivision. Continued growth in traffic and changing conditions may also require changes in cycle time and separate turning phases.

  Intersection layouts - channelization, left turn bays - can also be redesigned to complement signal timing for better traffic flow.

  If traffic lights are required at the intersections of major and minor roads, semi-actuated signals are preferable. These signal systems can be programmed to maintain constant green on the major road, providing green time for the minor road only when a vehicle or pedestrian wishes to cross.

  At major intersections fully-actuated signals are necessary. Sophisticated electronic controls are also available for on-site programming to handle more complex traffic patterns.

  On major arteries steps can be taken to optimize traffic flow. Timing signals to provide a green "window" allows traffic to progress without stopping along the route, at or near the speed limit. This technique is most effective for fringe and suburban arterials which carry high volumes during a uni-directional commuter peak period.

  By using synchronized simultaneous signal changes, bi-directional volumes of traffic can also be accommodated during peak periods, providing energy efficiency in both directions.

  Further improvements to traffic flow can be achieved by using a centralized, computer-controlled system.

Other techniques to improve traffic flow include:

- Grade-Separated Crossing Facilities for Pedestrians - These facilities increase vehicle speeds by reducing the number of stop-and-go movements and vehicle idling.

- Reversible Lanes - Reversible lanes should be considered where there are severe directional imbalances in the municipal road system. Some lanes, for

example, could function one-way into the downtown area in the morning and in the reverse direction in the evening.

- Intersection Channelization (i.e., left and right turn lanes) - Channelization helps to eliminate obstructions to through vehicles.

- Bus Bays - Bus bays allow buses to pull out of the main flow of traffic at transit stops.

- One-Way Streets - These increase street capacity and decrease flow interruptions caused by turning vehicles. Such advantages are offset by increased travel times in some cases.

- Turn Prohibitions - Turn prohibitions improve flow of through traffic at intersections. If the number of turning movements is relatively high, however, any benefits to through traffic may be offset. Considerable extra energy can be consumed by vehicles forced to travel a greater distance to turn.

5- Walking and Cycling as Substitutes for Automobiles

Walking and cycling can also be attractive transportation options. Since at least 50% of automobile travel involves trips of less than eight kilometres, and vehicle fuel economy for short trips is 20% lower than the urban average, these alternatives offer considerable scope for reducing fuel consumption.

Short-term measures to promote walking and cycling can be incorporated with little difficulty into existing urban land use patterns, and this discussion is limited to measures of this type. Long-term measures involve a much more radical change in the form of urban areas and are primarily aimed at reducing trip lengths.

- Encourage Pedestrian Travel - Convenience and safety are the central issues in any program aimed at pedestrians.[14] Convenience can be increased by providing pathways that lead directly to trip destinations, are clearly marked, involve few turns and grade changes, minimize delay and provide pedestrians with a feeling of security when walking at night.

  Pedestrian safety depends on the following factors:

  - Adequate lighting
  - Crossing facilities (e.g., crosswalks, pedestrian traffic signals, grade-separated structures)
  - Physically separated paths

- Encourage Travel by Bicycle - Cyclists travel at three to four times walking speed for the same level of effort. As an alternative to automobile use, therefore, cycling is even more important an option.

  Many design considerations for pedestrian facilities must also be taken into account when providing bicycle facilities. Cyclists making trips for non-recreational purposes place high priorities on such characteristics as directness of routes, acceptable grades, minimal delay, and conflicts with other types of traffic.

- Provide Appropriate Facilities - The key design elements are pathways and crossing facilities. Another important factor is the degree to which pathways are reserved for bicycle use.[15]

  The three common modes of travel - by vehicle, by bicycle and on foot - are basically in conflict. Physical separation may therefore be important for safety and for perceived safety, not only between cars and pedestrians but also between pedestrians and cyclists. A dividing line down a combined bike/footpath may be sufficient to eliminate problems.

Pathway types include:

- bikeways which are completely physically separated from roadways
- bike lanes which are part of the roadway, but which are separated by means of a barrier, e.g. curbs, from vehicle traffic
- bike lanes which are separated by pavement markings and warning signs

Crossing facilities to aid bicycle movement include:

- Bicycle curb ramps
- Bicycle left turn lanes
- Off-set pathway crossings
- Grade separations
- Traffic signal movements - increased caution time and cyclist-activated signals, i.e., conveniently located pushbuttons.

Finally, any program to promote cycling must provide secure storage facilities at places of employment, shopping centres and transportation terminals.

6- Planning Policies to Reduce Travel Demand

Land use patterns in communities have important energy implications. Any land use configuration which brings residential areas, employment centres, commercial and recreational areas closer together reduces dependence upon the automobile and shortens trip lengths. Trip lengths can become short enough to make walking and cycling acceptable options; less fuel is consumed by motorized vehicles because distances are shorter; and public transportation becomes more attractive because trips are shorter and more direct.

There are essentially two aspects of planning where policy changes can affect gasoline consumption in a community,[4] zoning changes and new development planning.

- Zoning Changes - Zoning can be changed to encourage mixed land use in urban areas, allowing new employment opportunities and neighbourhood shopping facilities in areas formerly restricted to residential land use, and encouraging housing within convenient walking distance of jobs and stores. Long distance commuting and travel to suburban shopping centres would be reduced as a result. With essential activities dispersed throughout an urban area, heavy and unbalanced traffic flows would also be alleviated. This would improve traffic circulation, result in a more efficient utilization of existing roadway facilities and eliminate the need to provide increased road capacity.

  Zoning regulations can also be modified to encourage higher residential densities, particularly around transit stations and along transit corridors. Increased densities will also mean less space needed for roads and, consequently, less energy to construct and maintain them.

- Planning for New Development - In many cases municipalities can promote energy sensitive urban design by establishing appropriate development guidelines. In terms of transportation, planning guidelines can encourage mixed land use so that most daily activities can be carried out locally. Street layouts can minimize long curvilinear streets and cul-de-sacs which mean extra driving distances for all vehicles, particularly those providing delivery and municipal services. Restrictions on strip development can be introduced. Cluster development can be promoted to reduce street lengths, and subdivisions can be planned to ensure easy access to transit.

  Municipal planning can also include provisions for pedestrian walkways and bicycle paths between residential units and other neighbourhood activity centres such as schools, shopping centres and recreational facilities.

7- Reducing Energy Requirements for Roads

Road construction and maintenance consume a substantial amount of energy. Building one kilometre of a two-lane road constructed of asphaltic concrete - the type of roadway surface predominant in Canadian municipalities - requires the energy equivalent of approximately 250,000 litres of gasoline. About 80% of this energy is accounted for by the asphalt alone.

Although most municipalities contract for their major construction projects, the potential for energy savings suggests that energy consumption can be an important factor in evaluating tenders.

Alternatives for construction

- Use of Concrete - In the past, concrete has accounted for a very limited number of kilometres of roadway due to the high installation cost. Viewed in terms of energy consumed for an equivalent

kilometre of two-lane road, however, concrete uses about 4% less energy than asphalt (an energy saving equivalent to about 10,500 litres of gasoline).[16] As the cost of asphalt increases, concrete will become increasingly attractive from a cost-saving point of view.

- Recycling Asphaltic Concrete - Deteriorated asphalt can be used for reconstructing and resurfacing existing roads. In this case energy savings arise from reuse of the energy intensive binder as part of a new sub-base or surface course.

  There are different methods of recycling asphalt, any one of which could be considered or specified as part of a reconstruction or resurfacing project. The operation can be done either in-place or through a central plant. The surface course can be pulverized to varying depths. It can be recycled using the hot or cold mix method.

  Actual energy savings from the recycling of asphaltic pavements vary with the methods used. Experiments conducted using full-depth hot mix techniques, for instance, indicate that it may be possible to save about 50% of the asphalt.[16] The following describes the various hot mix techniques:

  - Reducing the moisture content of the aggregate going to the dryer by covering stockpiles, loading the cold feed bins by picking up material from the outside of the pile, allowing water to drain from the cold bins by leaving the gates slightly open and turning over stockpiles to expose the aggregate to the drying power of the wind and sun.

    These steps can save about 10% of the fuel needed to dry and heat the aggregate (26,000 BTU's per ton or 550 litres of gasoline per kilometre of two-lane road).

  - Reducing the fuel required to heat the aggregate by controlling the volume of air in the dryer, reducing the stack temperature by rearranging the flights in the dryer, and improving the combustion processs. These amount to a further 10% reduction in fuel required to dry and heat the aggregate.

  - Using a drum dryer mixer plant. The Asphalt Institute has estimated that about 3,200 BTUs per ton of mix can be conserved by lowering mixing temperatures of drum dryers. This amounts to about 280 litres of gasoline per kilometre of two-lane road.

Road maintenance operations

Aside from benefits to be derived from a fleet management program, there are other energy-saving possibilities through adjustments to the levels of service, mainly in snow-oriented maintenance and roadside maintenance.

Reducing the level of road surface maintenance is not recommended, however. Any savings in fuel and energy-intensive material are heavily outweighed by the increase in fuel consumption of vehicles travelling over a deteriorated surface, not to mention additional factors such as tire wear. In fact higher rather than lower standards of maintenance should be adopted.

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